UNITED STATES AIR FORCE HEALTH CARE PROVIDER PRACTICES: SKIN TESTING FOR MYCOBACTERIUM TUBERCULOSIS

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HEISTERMAN

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SKIN TESTING FOR *MYCOBACTERIUM TUBERCULOSIS*

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Abstract

Mycobacterium tuberculosis (TB) is an infectious disease of global concern. The World Health Organization (WHO) estimates that 20 million active tuberculosis cases infect another 50 to 100 million people each year. Military medical units have traditionally focused on the mastery of casualty care. Data shows traumatic injuries represented a mere fraction of the medical care provided during Operation Desert Shield/Desert Storm. In addition, humanitarian and peace-keeping missions have become an important part of recent military missions. Primary care and treatment of infectious diseases, a major focus of nurse practitioner (NP) practice, are becoming the challenges of today's deployments. The purpose of this descriptive correlational study was to describe Air Force health care provider's knowledge of TB skin testing principles and investigate relationships between demographic variables and that knowledge. Respondents were a convenience sample of 172 Air Force health care providers at a mid-level medical treatment facility including: medical doctors (MD), doctors of osteopathy (DO), physician assistants (PA), nurse practitioners (NP) and independent duty medical technicians (IDMT). The study questionnaire consisted of ten demographic data questions and eight multiple choice questions concerning current guidelines for tuberculosis skin testing. Data were analyzed using descriptive and inferential statistical methodology. Results were reported in an effort to describe the current demographics, state of knowledge and relationships between the two in a sample Air Force health care providers.

UNITED STATES AIR FORCE HEALTH CARE PROVIDER PRACTICES: SKIN TESTING FOR *MYCOBACTERIUM TUBERCULOSIS*

by

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THESIS

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PREFACE

> Ingenuity, knowledge, and organization alter but cannot cancel humanity's vulnerability to invasion by parasitic forms of life. Infectious disease which antedated the emergence of humankind will last as long as humanity itself, and will surely remain, as it has been hitherto, one of the fundamental parameters and determinants of human history (McNeil, 1976, p. 12).

In 1994, a year after declaring a global emergency, the World Health Organization (WHO) stated, "It is no longer possible to eliminate infectious disease in one corner of the world and let it run rampant in another" (O'Meara, 1994, p. 1640). Control of *Mycobacterium tuberculosis* (TB) in the industrialized nations is possible only if it is reduced as a threat in Africa, Asia and Latin America. Current statistics show increases in TB and multi-drug resistant TB (MDR TB) in Eastern Europe and the former USSR (Raviglione, Grzemska, Alisherov & Limarev, 1996).

Dr. Hiroshi Nakajima reported that TB (a) is rapidly spread; fueled by travel, migration, and the HIV/AIDS epidemic; (b) accounts for 30% of AIDS deaths; (c) is the leading killer of women; (d) orphans more children than any other infectious disease; and (e) kills more people than AIDS, malaria, and tropical diseases combined. For each well publicized death from the Ebola virus, more than 12,000 anonymously die from TB. At its' current rate, TB will kill 30 million people over the next decade (WHO, 1996a).

It is with clear memory of the impact of infectious disease upon troops in Vietnam that this topic was chosen. Fortunately, medics no longer unwittingly face the risk of blood borne pathogen disease as they perform their roles in trauma medicine. United

States military personnel are interjected into the global situation as well protected as current technology allows. But health care providers bear ultimate responsibility for clinical decisions which may impact the long term health of individuals and the over all war-fighting capabilities of the military organization. Accurate knowledge of tuberculosis skin testing principles represents one piece of an increasingly complex mission called “readiness”.

DEDICATION

To my sister Judie who lit the lamp
and marked the path

My example, my mentor and, most of all, my friend

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Introduction

Mycobacterium tuberculosis (TB) is one of this decade's most rapidly spreading afflictions. Health care practitioners are being challenged to both identify and treat this insidious disease. One of the elements necessary to achieve this outcome is a thorough knowledge of the diagnostic testing procedures specific to TB. The purpose of this descriptive correlational study is, first to describe Air Force health care providers' knowledge of (TB) skin testing principles and second, to determine if health care provider-specific demographic factors are predictive of that knowledge. This topic is important because tuberculosis prevention and treatment policies are founded upon epidemiological and clinical information gained through accurate, or inaccurate, tuberculin skin test procedures. Comprehensive understanding of tuberculin skin testing requires knowledge of (a) factors related to the person being tested, (b) the material used, (c) the method of administration, and (d) the interpretation and recording of test results (Comstock et al., 1981).

Experienced immunization technicians, currently administering and interpreting skin tests in medical treatment facilities, are not ordinarily included in deployed units (Major C. H. Graves, McGuire Air Force Base, personal communication, September 9, 1996). Air Force Instruction 48-110 (1995) details responsibilities related to administration of immunizations and chemoprophylaxis, but it does not address deployment of immunization technicians themselves.

Recent years have witnessed a change in the principal role of military medical personnel from one of combat support to one of diversified operations in which the primary goal may be support of humanitarian relief. Recipient nations, often struggling economically and politically, may be endemic areas for infectious diseases, such as TB, with which some United States military medical personnel have little first-hand experience.

Historical Background

Mycobacterium tuberculosis is an ancient disease which is making a disturbing reappearance. Its antiquity is documented in 2500 year old pre-Columbian American and Old Kingdom Egyptian art and skeletal remains. Both show unmistakable evidence of spinal tuberculosis or Pott's disease (Last & Wallace, 1992; Schlossberg, 1994). Ancient and modern cultures throughout the world have called tuberculosis by many names: phthisis, poitrinaire, consumption and King's Evil are a few (Last & Wallace, 1992; Webb, 1936).

For centuries miasma, or bad air, was thought to be related to development of disease. Aristotle is generally given credit for first observing the contagious nature of TB. He spoke of breathing "pernicious air" when approaching a "consumptive" (Webb, 1936). Hippocrates in Greece, and Sun Tzu in Asia both recognized the importance of a healthy environment for disease prevention. In 400 BC Hippocrates described the ideal location for a city as one where there was a fast running water supply, purified by exposure to the sun. (Hippocrates, 325 BC/1952). The Chinese warrior Sun Tzu, 100 years earlier, advised armies to bivouac on high, sunny ground. He concluded, ". . . while

nourishing its health, the army occupies a firm position. An army that does not suffer from countless diseases is certain of victory" (Sun Tzu, 500 BC/1971).

Seventeenth century public health concern was evidenced by an Italian decree making tuberculosis a reportable disease. Not all seventeenth and eighteenth century physicians agreed, however. Valsalva, an Italian pathologist, taught his students to refuse to autopsy consumptive patients. His verbal opponent, Laennec, strongly disagreed. Laennec had devoted much of his life to study of pulmonology, particularly phthisis (TB). He also is credited with the development of basic technology and technique for auscultation. Correlating extensive notes obtained through auscultation of living subjects with later autopsies of the same, he was able to define breath sounds characteristic of infiltrate, tubercles and cavities of tuberculosis (Dubos & Dubos, 1952). Later, through self-auscultation, he found he had acquired cavitary symptoms of TB. Only then did he concede that extensive performance of autopsies was the apparent cause (Sepkowitz, 1994).

The 1882 discovery of the tubercle bacillus by the German bacteriologist, Robert Koch (1843-1910), transformed the scientific and public view of tuberculosis (Howard & Solomon, 1988). In 1890, Koch developed tuberculin from culture filtrates of *Mycobacterium tuberculosis*. Thought, at first, to be a cure for the disease, it was quickly proven a failure. The research did, however, discover what became one of the most widely used clinical diagnostic tools ever—the tuberculin skin test (Huebner, Schein & Bass, 1993).

In the early twentieth century, the sanitarium movement and legally mandated tuberculosis reporting represented major components of the United States TB control program (Comstock, 1994). Despite these positive public health steps, disagreements about the communicability of TB reemerged. Fishberg (1915) and a number of other European physicians, felt evidence indicated that close contact with pulmonary, and even laryngeal, tuberculosis posed no risk for healthy adults. Shortly after Fishberg's assertion, a number of compelling studies evaluated the TB conversion rates of nursing and medical students. This research lead to widespread recognition of TB as a valid occupational hazard (Heimbeck, 1928; Boynton, 1939; Myers, Diehl, Boynton, Ch'iu & Streukens, 1940).

Israel, Heatherington & Ord (1941), published their classic American study of student nurses. From 1935 through 1939 they investigated 643 students at Philadelphia General Hospital School of Nursing. Over 90% (578) of the students were17 to 21 years of age at the beginning of observation. Of the 277 initially skin test negative, 48% (133) reacted to tuberculin by four months into their training. By one year, 85.9% (238) had reacted; and at the end of three years 100% (277) had converted to positive (Israel et al., 1941). Abruzzi and Hummell (1953), summarized available data on 42,000 medical students during the period from 1940 to 1950. They found 557 cases of tuberculosis in 166,959 student-years, a rate of 3.34/1000 per year. The rate in the general population for the same time period was 0.32 to 1/1000 per year.

Another classic study of 1953, demonstrated that direct patient contact, such as duties of nurses and technical workers, afforded substantially greater risk for active

tuberculosis than those at the same institution without patient contact (Mikol, Horton, Lincoln & Stokes, 1953). This study utilized a convenience sample of employees at three 250 bed New York state tuberculolsis hospitals over a period from one month to 157 months. The rate of tuberculosis among employees working in exposed occupations was 13.4/1000 person-years. The rate among non-exposed occupations was 1.5/1000 person-years. The rate was highest in the nursing group (20.9), but they were also elevated for employees in the technical (12.3), ward dietary (10.6), laundry (8.7). and housekeeping (7.4) groups. In spite of this and other studies, arguments about transmission of TB persisted well into the 1950s. Arguments were fueled by fear that if communicability of TB became established fact, it would become difficult to recruit nurses (Sepkowitz, 1994).

The development of antibiotics, in the 1940s led to a sharp decline in the incidence of tuberculosis. The decrease was so profound that the medical profession planned for swift eradication of the disease. However, with this success, interest shifted and funds were reallocated. Infection rates among physicians began to grow (Barrett-Conner, 1979; Malasky, Jordan, Potulski & Reichman, 1990). Belief that TB was curable and inexpensive to treat had led to complacency and inattention in the medical community (WHO, 1996b).

In 1985 the downward trend in TB morbidity and mortality dramatically reversed itself. Tuberculosis related morbidity increased 14% from 1985 to 1993 (Simone, 1995). Poor treatment follow-up played a significant role in the development of multi-drug

resistant tuberculosis (MDR-TB). MDR-TB is more difficult and expensive to treat and has the potential to reverse progress nearly to pre-antibiotic times (Sbarbaro, 1996). The appearance of MDR-TB strains is particularly alarming when the possibility is raised of their mutation into even more complex, universally pathologic, and deadly organisms (Grimes & Grimes, 1995).

Today the tuberculosis rate in the United States has increased for several reasons. First, there has been a sharp increase in immigration from countries where TB is prevalent. Secondly, transmission of TB in congregate settings such as long-term health care facilities, prisons, homeless shelters and drug treatment centers has increased dramatically. Third, and probably statistically most significant, is the HIV epidemic. Finally, there is a lack of adequate support services (The American Lung Association, 1996). Approximately 10% of untreated persons infected with TB bacilli will develop clinical tuberculosis disease during their lifetime. If untreated for latent infection, HIV infected individuals have a 50% chance of developing active disease within 60 days, and a 10% annual risk for active disease (American Thoracic Society, 1990; Benenson, 1995; Hinman, 1993).

MDR-TB, recognized as a problem of the United States, has begun to occur in countries throughout the world (WHO, 1996b; WHO, 1996d). Wherever the medical infrastructure is overwhelmed, the danger of failed treatment and subsequent MDR-TB increases. In a recent article, the World Health Organization (WHO) reported the TB situation in Eastern Europe: from 1990 through 1994 reported cases doubled, to 30/100,000 in Estonia, to 41/100,000 in Latvia, and to 28/100,000 in Lithuania. In

Sweden, for the same period, the rate was only 6/100,000. Multi-drug resistance was reported in 10-20% of the cases in Eastern Europe and Scandinavia ("Epidemiology: Tuberculosis," 1996).

Tuberculosis and Skin Testing

The pathogenesis of TB involves transmission of *Mycobacterium tuberculosis* bacilli by droplet nuclei. These droplets, one to five microns in size, are inhaled into the lung where they are engulfed by macrophages which transport them to hilar or mediastinal lymph nodes. From there they disseminate, lodging most commonly in the apex of the lung. Over time, usually about 10 weeks, the immune system, T-cells and other mediators, effectively arrest bacillary growth by entrapping the bacillus in solid tubercles. In the tubercles they remain dormant, but viable. The body, as a result of the initial contact with TB, activates antigen specific antibodies which destroy any bacilli left free in the system. This condition is known as TB 'infection' or 'latent' TB (Leiner & Mays, 1996).

Active tuberculosis disease occurs when the bacilli begin to multiply, usually as a result of decreased immunity secondary to disease, chemotherapy or aging. Symptoms are variable, ranging from mild to debilitating cough with hemoptysis, weight loss, fever and night sweats. Active TB is only contagious when it affects the airways or is somehow aerosolized. Laryngeal tuberculosis is highly communicable. Droplet nuclei containing the bacilli can be established in air by coughing, laughing and singing. These may be widely dispersed on air currents, so recommendations for air handling and ventilation in medical facilities have been made by the Centers for Disease Control and Prevention

(1994b). The degree of communicability is theoretically determined by the concentration of bacteria in the air, and the duration of exposure. Crowded conditions and poor ventilation contribute to the spread of the disease (Jackson, 1996; Takashima, Cruess, McDonald, Duggirala & Gaydos, 1996).

Tuberculin skin testing is an example of a delayed hypersensitivity reaction (DHT). Although not 100% sensitive or specific, this test remains the recognized method for screening for TB in asymptomatic or undiagnosed persons (Joint statement of the American Thoracic Society and the Centers for Disease Control and Prevention [CDC], 1994). This type of reaction is characterized by: (a) slowed course, reaching the peak of reaction more than 24 hours after introduction into the skin; and (b) induration, caused by cellular infiltration.

Persons with sensitivity to tuberculin are considered 'reactors'. Those who change status, over time, from negative to positive test reaction are considered 'converters' (CDC, 1994b). Interpretation of the results of skin testing engenders a number of treatment and policy implications. Positive test results, based upon risk factors, health status, and age may require treatment with potentially toxic medications. Clusters of positive results within a medical facility may necessitate increased frequency of skin testing, change the risk category of the entire facility and cause extensive expenditure of resources to trace the source of a suspected outbreak (CDC, 1994b; Patterson, 1995).

A delayed hypersensitivity reaction indicates either previous infection with *Mycobacterium tuberculosis*, infection with a non-tuberculosis mycobacteria, or vaccination with bacille Calmette-Guerin vaccine (BCG) vaccine. Distinction between

reactions representing TB infection, previous BCG, and cross-reactions with other mycobacteria can be difficult. Generally, the larger the reaction, the more likely the *Mycobacterium tuberculosis* infection (Snider, 1985; U.S. Preventive Task Force, 1966).

Delayed hypersensitivity reactions to tuberculin antigen peak in intensity at 48 to 72 hours, and subside slowly over time. In the elderly or in those with infection in the distant past, the reaction may not peak until after 72 hours. In these cases a second test, administered approximately two weeks after the first will produce an accurate and timely 'boosted' reaction (CDC, 1994c). This second test should be read as if it were the only test and the results considered final. Many health care employers have begun two step skin testing of all new employees without documentation of previous testing within the past two or three years. This procedure can prevent potential hazards of treatment faced by those who convert to a positive skin test. These hazards include, among others, hepatotoxicity, toxic encephalopathy and optic neuritis (Ellsworth, Dugdale, Witt & Oliver, 1997).

The most acceptable tuberculin skin test is the Mantoux (Pugliese, 1992). Five units of purified protein derivative (PPD) are injected intradermally. Delayed hypersensitivity reactions will be detected when read 48 to 72 hours after application. But the tuberculin skin test is neither 100% sensitive nor 100% selective for *Mycobacterium tuberculosis*. Exposure to strains of *Mycobacterium* other than tuberculosis may confuse the test results (American Thoracic Society, 1981). The tuberculin skin test, however, remains the best tool available for screening an asymptomatic population. To conclusively diagnose active TB, further diagnostic testing is necessary: chest roentgenography, sputum smear, and

sputum culture. Culture remains the only absolutely definitive diagnostic tool (American Thoracic Society, 1981).

The tuberculin skin test is based upon the sensitivity of *Mycobacterium tuberculosis* to certain bacillus organism antigens in culture extracts or tuberculins. The type of tuberculin used, purified protein derivative - standardized (PPD-S), is internationally standardized. Five tuberculin units (5 TU) of this PPD are used for all skin testing. Other strengths of PPD exist, but are not useful for skin testing (Simone, 1995).

Tuberculoprotein, when diluted in a buffer has several important characteristics which affect it's efficacy. First, it is absorbed by glass and plastics. The manufacturer adds a small amount of another compound to reduce this absorption, but it should not be transferred from one container to another or left in syringes prior to administration. Second, the solution should be kept refrigerated, not frozen. And third, it should be stored in the dark to prevent light degradation (American Thoracic Society, 1990).

Administration of the tuberculin must be accomplished according to strict protocol. Accuracy of testing may be affected by introduction of the tuberculin either too deep or too shallow. The correct method of injection involves approach at a 30° angle, bevel up, resulting in a wheal six to nine millimeters in diameter in a site on the volar surface of the forearm (Grimes,Grimes & Graviss, 1996).

Host conditions may also affect the accuracy of the tuberculin skin test. False negative results may occur in those who have immunocompromising conditions, those who are malnourished, those who have severe illness or are febrile, and in those with

overwhelming *Mycobacterium tuberculosis* disease. In these cases it is appropriate to test for anergy by readministering tuberculin simultaneously with at least two other delayed-type hypersensitivity agents (eg. Mumps, *Candida,* and a 1:5 dilution of tetanus toxoid vaccine) in conjunction with the PPD test (Huebner et al., 1993; U.S. Preventive Task Force, 1996).

Documentation of skin test results involves a somewhat subjective assessment of size of induration produced. Some currently favor the 'ballpoint pen' method to evaluate tuberculin reaction. The reader, beginning approximately three centimeters from injection site draws a line transverse to the long axis of the arm until the pen reaches the firm area of induration. The procedure is repeated from the opposing side. The area between the proximal ends of the two lines is measured and recorded, in millimeters. Others prefer to use the fingertip palpation method to estimate size of induration. Erythema is not considered in any of the correct measuring techniques (Howard & Solomon, 1988; Pouchet et al., 1997).

Current interpretation of skin test results is based upon two factors. First, host risk factors, such as close contact with active tuberculosis infected individuals, personal health, BCG vaccination, age and chest roentgen results must be considered. The second involves evaluation of environmental risk factors including country of origin, current sociodemographics, occupation and living conditions (CDC, 1994c). The CDC guidelines, the most widely referenced and frequently used resource, consists of over 100 pages of detailed information about all aspects of TB prevention and control in health care facilities. The Occupational Safety and Health Administration (OSHA) utilizes these

guidelines as the standard by which they decide occupational safety concerns (U.S. Department of Labor, 1996). "The CDC Guidelines for Preventing the Transmission of *Mycobacterium Tuberculosis* in Health Care Facilities" were last updated in 1994 and are included in a joint statement by the American Thoracic Society, CDC, and the American Academy of Pediatrics (CDC, 1994c).

Military Background

Modern medical planners have built upon the contributions of past reformers. Nightingale, for example, collected data demonstrating that more men died from unsanitary conditions in the army hospitals during the Crimean War than from bullets on the battlefield. She showed that sanitation was so poor, even in garrison quarters, that the mortality rate of soldiers living in barracks was twice that of British civilians (Nightingale, 1859). Military nurse practitioners are concerned with many of the same issues today.

Professionally, nurses have been actively involved in formation of military medical policy. Currently, nursing personnel represent 19% (3/16) of the membership of the Joint Service Working Group for Medical Support of Operations Other Than War. This multidisciplinary, tri-service group includes: nurses, medical doctors and medical service corps members (Joint Service Working Group for Medical Support of Operations Other Than War, 1996).

The Chief of the Air Force Nurse Corps, Brigadier General L. J. Stierle, recently expressed a need for change in the implementation of operations other than war. She advocated increased use of family nurse practitioners. Mobility, she indicated, could be

used for truly humanitarian reasons, for training opportunities, and as a bridge to build relationships between countries. "Partnership for Peace", a natural disaster training initiative, is an example of this (personal communication, September 26, 1996).

Nursing Roles

Two primary nurse practitioner roles are of particular relevance to this study. First, authorities have long recognized the role of nurse practitioners in disease prevention. "In outcome measures of such tasks, nurses score consistently better in several areas, such as patient satisfaction, patient compliance, health promotion, and disease prevention" (Kassirer, 1994, p. 204). Secondly, nurse practitioners frequently utilize their talents in screening and management of acute and chronic illnesses. A meta-analysis of nurse practitioners (NPs) and certified nurse midwives (CNMs) in primary care, including 38 NP and 15 CNM studies, looked at 33 outcomes measuring performance of advanced practice nurses against that of physician providers. In studies employing randomization as to provider, greater patient compliance with treatment recommendations was demonstrated with NPs. Studies controlling for patient risk, in ways other than randomization, satisfaction and resolution of pathological conditions were greater for NP patients (Brown & Grimes, 1995).

Nursing theorists, including Orem (self-care), Pender (health promotion as an approach behavior), and Nightingale (disease prevention), paved the way for nurse practitioners. As health care providers, nurses continue, at a different level, to promote self-care, healthy behaviors, and disease prevention. The focus remains the same whether in the continental United States (CONUS) or in deployed locations throughout

the world (Nightingale, 1859/1946; Marriner-Tomey, 1994). Health promotion and disease prevention are critical elements for the maintenance of strong military forces. This is especially true when they are deployed to areas which are endemic for TB or other infectious diseases. For this reason, military nurse practitioners must be experienced in epidemiology, detection, treatment, and control of infectious disease.

Statement of the Problem

Military medical personnel from all services are deployed around the globe on a variety of missions. According to the Air Force Times of August 1996, more than 12,000 Air Force personnel were, at that time, participating in major deployments (Major Air Force Deployments", 1996). Most were with operations in the Persian Gulf and northern Iraq (8,421). A large portion were with the Bosnia peacekeeping mission in Eastern Europe (3,188). Smaller operations required personnel in Central and South America (568) and in the Caribbean (182). Numerous Air Force members were on individual deployment to a myriad of other locations. ("Major Air Force Deployments", 1996). These deployed personnel may be faced with conditions that either do not exist, or are rarely seen, in their CONUS practices.

The question this study is designed to examine is: Are Air Force health care providers prepared for key roles in the prevention and control of *Mycobacterium tuberculosis*? One indicator of this preparation is 'knowledge' of correct TB skin testing principles.

Medical Readiness Strategic Plan 2001 (MRSP), details the Defense Department's primary medical mission which is to provide medical services and support to the armed

forces involved in military operations (Department of Defense [DOD], 1995). It also states that US foreign policy experience requires the inclusion of peacemaking, peacekeeping and humanitarian assistance into the concept of 'medical support'. The military acronym OOTW, or operations other than war, refers to military missions in these three categories (DOD, 1995).

Data from Operation Desert Shield/Desert Storm shows that not only in OOTW, but in recent war-fighting missions, trauma care represents a fraction of actual medical services performed. Statistics show that primary care and prevention are the main function of deployed military medical personnel (Larino, 1997). The primary goal is to maintain the war fighting capability of essentially healthy personnel (Zimble, 1996).

Dr. James Zimble, President of the Uniformed Services University of the Health Sciences, recently wrote regarding military medicine:

> The medic must be experienced in infectious diseases, with special emphasis on global endemic diseases. . . . It is essential that the military medicine expert's focus be on disease prevention and health promotion anywhere that troops, usually immunologically naïve troops, might be deployed (Zimble, 1996, p. 186).

Mycobacterium tuberculosis is a globally endemic disease which should concern all military health care providers.

Conceptual Framework

The conceptual framework for this study is found in Abelin's approach to wellness. His approach is not the basic Host-Agent-Environment model of infection control, nor is it like many nursing models which focus only on the individual. He approaches health promotion from what he calls "factors influencing health" (Abelin, 1987, p. 31). His conceptualization demonstrates the complexities of maintaining balance between the individual or group of individuals and the physical and social environment. This balance, he suggests, is composed of the individual's or groups of individuals potential to cope with environmental challenges, and the type and degree of challenge. Lifestyle and behavior are factors that strongly affect wellness. They, in turn, are shaped by sociocultural systems. The physical-biological environment (water, air, food, housing and work environment) impacts the individual's health potential . The environment is influenced by social and political conditions that are, in turn, shaped by the same sociocultural system that affects lifestyle and behavior (see Figure 1).

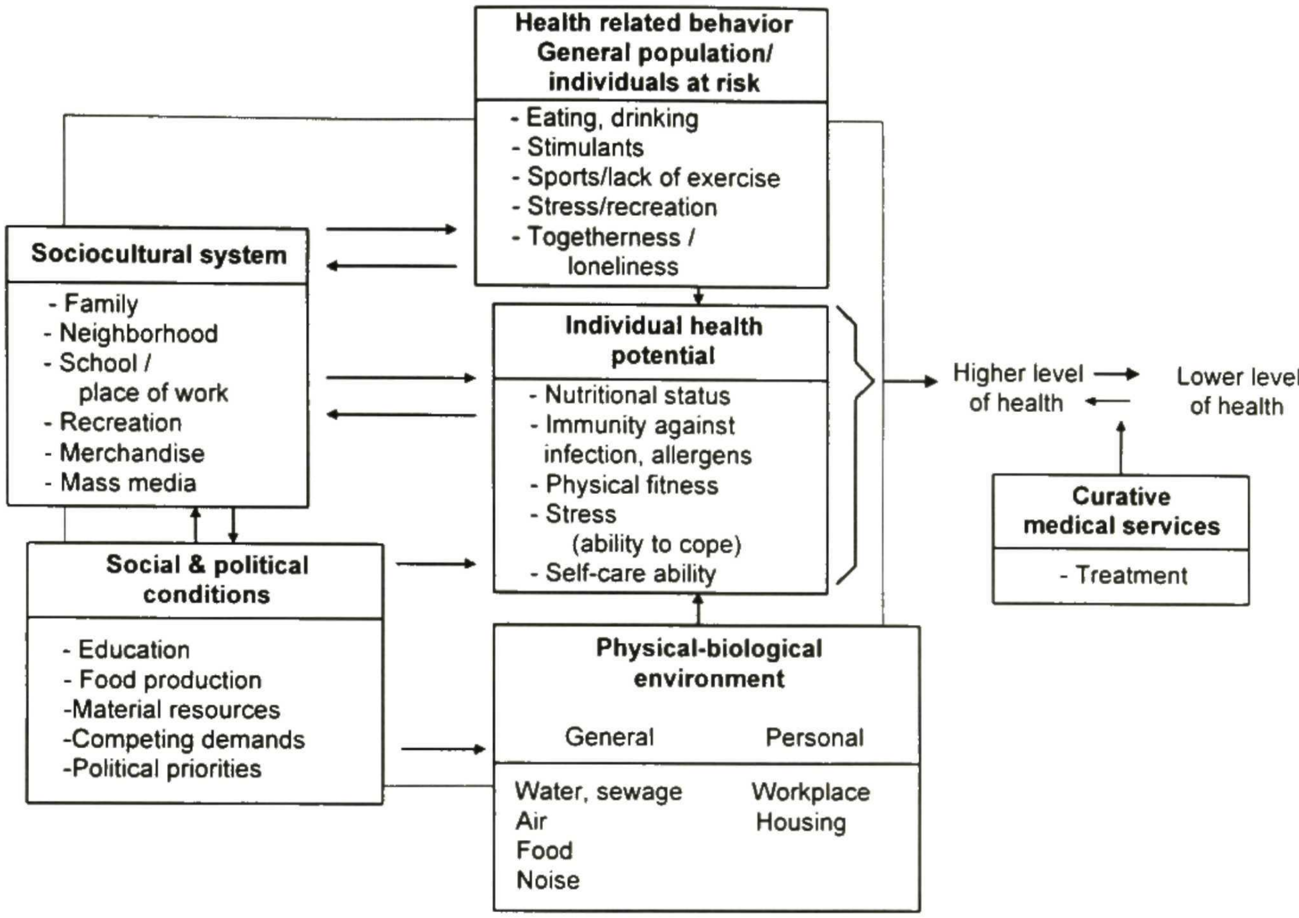

Figure 1. Factors that influence levels of health.
Note. From "Approaches to Health Promotion and Disease Prevention", by T. Abelin in Measurement in Health Promotion and Protection, (p.32), edited by T. Abelin, A.J. Brzezinski and T Carstairs, 1987, Copenhagen: WHO Regional Office for Europe. Copyright 1987 by World Health Organization. Reprinted with permission.

Abelin suggests that when health promotion is performed well, established goals relate to current conditions. He stresses that programs need to strongly consider local circumstances and finally, that implementation must be monitored using measurable criteria (Abelin, 1987).

This framework may readily be applied to military deployment. Group and individual health is affected by the environment, the environment by the sociopolitical factors, and so on. The process, much like the nursing process, includes three phases: (a) goals set prior to deployment are based upon health care providers knowledge of local

conditions (medical intelligence); (b) adjustments are made for subsequent developments; and (c) data is collected for analysis and planning of future deployments. The complexity of factors affecting health supports the complexity of the health promotion and disease prevention concept. Albelin (1987) proposes that, because of the number of factors affecting health, it is unlikely that one approach (for example, education) can adequately accomplish the goal, optimum health. In Figure 2 six areas of health promotion necessary for effective change are depicted. Note the direct influence that preventive medical and related services have on the three major components of health. In the case of deployed medical units, these units would most likely be tasked to fulfill the other requirements set forth by the Abelin model: Education, community health, environmental health, occupational health and curative services.

According to the Abelin's conceptual framework, preventive medical and related services have direct influence upon almost all major factors affecting levels of health: general population health related behavior, individual knowledge and behavior, and both general and personal physical-biological environment.

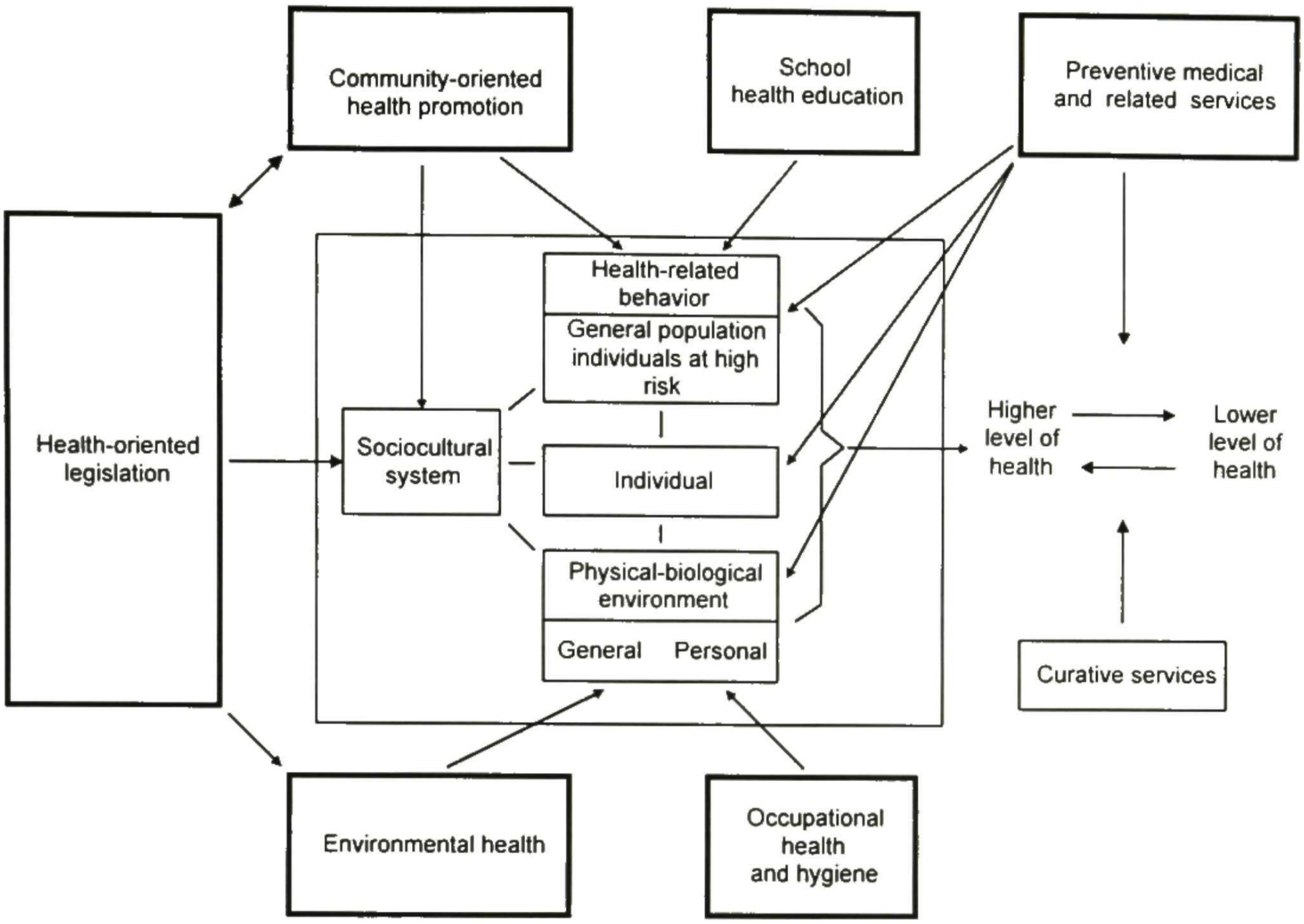

Figure 2. Approaches to health promotion based on factors that influence levels of health.
Note. From "Approaches to Health Promotion and Disease Prevention", by T. Abelin in Measurement in Health Promotion and Protection, (p.34), edited by T. Abelin, A.J. Brzezinski and T Carstairs, 1987, Copenhagen: WHO Regional Office for Europe. Copyright 1987 by World Health Organization. Reprinted with permission.

Recognizing the importance of the overall picture and the potential influence of preventive medical and related services, this study examines a small, untested portion of the conceptual model: the situation specific knowledge (and possible demographic factors effecting that knowledge) of those involved with providing preventive and related medical services (see Figure 3).

Preventive medical and related services

KNOWLEDGE OF TUBERCULOSIS SKIN TESTING GUIDELINES

- Age
- Healthcare provider role (MD, DO, PA, NP, IDMT)
- Board certification
- Source of education (civilian university, USUHS, specialized military training)
- Military experience (number of years in the military and type of deployment history)
- Medical experience (year of graduation, number of years as military health care provider)
- Tuberculosis experience (number of cases diagnosed or treated)
- Local unit compliance with regulations (date of last PPD)

Figure 3. Demographic factors potentially affecting provider knowledge of tuberculosis skin testing.

A recently published report in Military Medicine bears the titie, "Military medicine in operations other than war part II: Humanitarian relief missions for Naval reserve fleet hospitals" (Ryals & Baker, 1996). The article presents a scenario to which the Abelin model can easily be applied. These authors contend that complex humanitarian missions need to consider: (a) displaced populations, (b) destroyed infrastructure, (c) the need for public health and primary care and (d) the need to integrate medical assistance into the host nation, poising it for continuation after U.S. withdrawal. Health promotion and disease prevention will be of prime importance. The authors of this report reinforce what

the military planners have known for some time: complex humanitarian missions rely heavily on primary care physicians, nurse practitioners, and physician assistants.

Definition of Terms

For the purpose of this study the following key operational terms are defined:

Air Force health care provider: shall be any of the medical personnel who may be deployed in a health care provider role including medical doctors, doctors of osteopathy, physician assistants, nurse practitioners and independent duty medical technicians.

Knowledge of tuberculosis skin testing: shall be defined as: (a) score of 80% or better on the entire16 element test in section B of the research tool, or (b) score of 80% or better on the first 10 basic elements of section B of the research tool.

Tuberculosis skin testing: is considered the Mantoux or intradermal testing with five tuberculin units (5TU) purified protein derivative (PPD) in the volar aspect of the forearm.

For a complete glossary of terms found throughout this report, see appendix C.

Limitations

Limitations to the study include sample size and generalizability. The sample is a convenience sample including Air Force health care providers from one mid-sized medical facility. The medical facility is the home of one of the major Air Force residency programs for physicians. This factor alone may skew the results, giving a higher percentage of academically involved, and therefore more aware, physicians than would otherwise be found. Sample size (52 medical doctors, two doctors of osteopathy, two nurse practitioners, six physician assistants and three independent duty medical

technicians) is insufficient to make generalizations about the larger Air Force health care provider population or any of the sub-populations surveyed.

Design limitations include: (a) testing by questionnaire alone, rather than by both questionnaire and direct observation of health care provider's actual reading and interpreting of skin tests (b) administration of the questionnaire in an uncontrolled setting in which a portion of respondents may have collaborated or utilized reference materials and; (c) use of a multiple choice format rather than the more comprehensive open-ended format.

Assumptions

Two assumptions have been made concerning this study. It is assumed that Air Force health care providers all have potential deployment roles outside of CONUS. It is also assumed that respondents will read the research survey and make an effort to answer all questions honestly.

Summary

This chapter has briefly detailed a descriptive correlational study in which Air Force health care provider knowledge of skin testing was evaluated. The chapter traced the natural history of *Mycobacterium tuberculosis* and its' effect on mankind throughout the ages. Statistics demonstrating the continued presence of tuberculosis as a major world health problem were discussed. Multi-drug resistant tuberculosis as a world problem, caused partially by medical establishment complacency and poor treatment follow-up, has been established. Studies which consistently implicate crowded conditions, poor ventilation, immunocompromising physical conditions and certain occupations were

presented. Military missions and their inherent risks from TB were discussed and TB skin testing, as the recommended method of screening an asymptomatic population, was described. The next chapters are devoted to the review and discussion of current literature, the methodology utilized in conduct of this study, the presentation and analysis of data, and the implications of the study.

CHAPTER TWO: REVIEW OF RELEVANT LITERATURE

Introduction

The purpose of this study was to, first, describe Air Force health care provider's knowledge of *Mycobacterium tuberculosis* skin testing principles and second, to determine if demographic factors are predictive of that knowledge. This is important because clinical treatment and environmental control decisions depend upon the epidemiological information gained through accurate (or inaccurate) tuberculin skin testing. Health care provider knowledge must include factors related to: (a) the host or person being tested; (b) the material or tuberculin used; (c) the method of administration; and (d) the interpretation and documentation of the results of the tests (Comstock, et. al. 1981).

News reports related to infectious or particularly virulent forms of disease have become increasingly common. Antibiotics no longer promise quick eradication of infection. Health care practitioners may be faced with resistant strains of bacteria in their practices (Snider, 1997). In this constantly changing world health arena, there is a paucity of recent studies addressing the role of the nurse practitioner in dealing with these critical issues.

Nurse Practitioner Roles

The World Health Organization (WHO), an agency of the United Nations, carries the primary responsibility for international public health. Through the WHO, health professionals from approximately 200 nations exchange knowledge of epidemiological and clinical concern. An issue of priority for the WHO is the diversion of individual

national and regional funds from health and social issues to all levels of conflict. Mobilization of resources to help individuals and families caught in these circumstances is a priority. The WHO describes nurse practitioners as "health care providers who, because of knowledge and experience have much to offer in the areas of health care assessment and policy development" (WHO, 1996c).

Governing and professional organizations have described the appropriate role of nurse practitioners in the United States. The American Nurses Association (ANA) describes the nurse practitioner's scope of practice as encompassing in part: provision of primary health care to individuals and families including promotion of health and prevention of disease. The ANA also states that nurse practitioners may manage actual and potential health problems, common diseases and human responses to diseases (ANA, 1987).

The American Academy of Nurse Practitioners (AANP), a professional association of NPs, has published standards of practice for nurse practitioners. According to this document, nurse practitioners assess, diagnose, develop a treatment plan and implement treatment. Among actions of nurse practitioners are: accurate conduction and interpretation of diagnostic tests, prescription of pharmacologic and non-pharmacologic therapies, provision of patient education, and appropriate referral to other health care professionals and community agencies (American Academy of Nurse Practitioners [AANP], 1993). Nurse practitioners, according to this document, also promote a safe environment . Infectious disease is not specifically mentioned, but it would appear nurse practitioners would be wise to learn to administer and interpret tuberculin skin testing. It

is also be prudent for NPs to understand TB treatment, prophylaxis, and critical health follow-up. Finally, NPs need to learn techniques of epidemiology needed to maintain a safe environment, especially in a deployed status.

United States uniformed services participated in at least six major humanitarian assistance operations in the period 1991 to 1994 (Lillibridge, Burkle & Noji, 1994). These included civil conflict in Somalia, Northern Iraq, and the former Yugoslavia, as well as hurricane or typhoon relief in Florida, Hawaii, and Bangladesh. The 1991 to 1992 Haitian exodus required a large U.S. humanitarian response. This growing list further documents the fact that the pace of humanitarian missions is intensifying.

The Navy has documented the Guantanamo Bay experience from a humanitarian and an epidemiological perspective. One recent article recounts the preventive medicine efforts at the Haitian refugee. Specifically addressed was the potential for disease transmission associated with overcrowding. Of particular importance, the physicians reported, was concern that health care workers were the group of DOD personnel at greatest risk for acquiring disease from the migrants camps (Herip & Slaten, 1992).

Nurse practitioners, by their own standards of practice, are required to maintain expertise in those areas of medicine necessary to assume a leadership role in the provision of a safe environment. From their roots in nursing, they have strengths in patient education, assessment, health promotion, and staff education. With this, and the skills assimilated in diagnosis and treatment, nurse practitioners are prepared to assume a leadership role in the prevention of infectious disease and the judicious care of persons who acquire infectious diseases (Cohen & Larson, 1996).

Current Issues in *Mycobacterium tuberculosis*

The issue of TB communicability has resurfaced. This is at least partially due to Centers for Disease Control and Prevention (CDC)1994 Guidelines for Preventing the Transmission of *Mycobacterium tuberculosis* in Health Care Facilities and the Occupational Safety and Health Administration (OSHA) regulations regarding respiratory protection. Expensive to implement, compliance spurred almost immediate inquiry into their efficacy (Beckett, 1995; Nettleman, 1995). Although new, less expensive OSHA acceptable masks were quickly developed, other controls (negative pressure rooms, air exchanges and UV lighting) were also costly. The argument has not been settled. Debate is especially heated in areas of the United States where TB risk is low and controversy over the issue seems to have further confused practitioners (The American Lung Association, 1996).

With the advent of antibiotics, funding for new medications, new methods of detection, and a new vaccine was reallocated (Sbarbaro, 1996). A large portion of current literature is devoted to HIV/TB complex , MDR-TB, and TB outbreaks in areas of high prevalence (New York and Florida). Studies of specific population groups have identified areas of increased risk. Disadvantaged and medically underserved persons living in crowded environments have the greatest risk for tuberculosis (American Thoracic Society, 1992).

Although new laboratory technology has been developed to identify strains of TB and to decrease the culture time, most of the large studies were done in the 1930 through

1950 time period (Snider, 1997). A scant body of literature exists on the development of new prevention, screening or treatment modalities.

Little research has been published describing health care provider knowledge, attitudes and practices related to TB. However, anecdotal information about health care provider knowledge of tuberculosis is available. Examples of actual comments made during the implementation of the 1994 CDC Guidelines included the following. "We don't have to worry about tuberculosis control; we are a young healthy population." (Personal communication, Air Force lieutenant colonel, MD, Mountain Home Air Force Base, ID, April, 1995). "What's the big deal about TB? You have to sleep with someone for twelve years before you can get it."(Personal communication, Navy physician, USS Comfort, March, 1996). "Why are you concerned about respiratory protection? We won't be taking care of any local nationals. . . just American military." (Air Force senior ranking medical technician, Mountain Home Air Force Base, ID, May, 1995; while packing for deployment to an unknown African location). These comments, and many like them, indirectly express little knowledge of or confidence in *Mycobacterium Tuberculosis* guidelines provided by the World Health Organization, the Centers for Disease Control and Prevention and the American Thoracic Society.

Studies of *Mycobacterium tuberculosis*

Two recent studies have looked at level of health care provider knowledge concerning diagnosis and treatment of *Mycobacterium Tuberculosis*. The first was a study of knowledge, attitudes and practices among South Korean physicians (Hong et al., 1995). Surveys were distributed to over 900 practitioners in 29 locations throughout

South Korea. A random sampling from 29 of 271 health centers was performed, and 1000 providers were surveyed. Test reliability and validity was not addressed in the publication. A 92.3% (923/1000) response rate was elicited through interview with pre-trained interviewers from June to August 1993. Of the 923 practitioners, only 53.2% (491/923) claimed to have treated TB patients (Hong et al., 1995).

When questioned about the magnitude of the TB problem in Korea, 60% (554/923) of the respondents considered tuberculosis to no longer be a serious problem in Korea. According to a March, 1996 report Southeast Asia has 39% of the 1,298,999/3,354,139 worldwide reported cases (WHO, 1996c). This is more disturbing when results of the survey reported only 50.1% (246/491) of physicians notify health authorities of new cases. Forty-two percent (100/491) of respondent practitioners were unaware that TB was a notifiable disease . Of 437 respondents, 73.2% (320/437), were prescribing medication regimens not currently recommended; and 16% (69/437) were giving blatantly unacceptable treatment. A positive note was that 80% (738/ 923) of the total respondents indicated a desire to know more. The investigators concluded that Korean physicians do not know enough about tuberculosis. Can this be generalized to the U.S. physician population? Probably not. But the World Health Organization has repeatedly expressed concern about world-wide complacency and poor management of control programs (WHO, 1996b).

The second major study concerning health care provider knowledge was conducted by the United States Centers for Disease Control and Prevention (Sumartojo, Hale & Geiter, 1994). At the time of this preliminary report, the study had elicited 1,772

responses from an original sample of 3,600 (48%). The subjects consisted of physicians working in infectious disease, pulmonology, pediatrics, geriatrics, internal medicine, public health, and family or general practice. The 12-page questionnaire was conducted by mail in selected cities, ranking among the 10 highest tuberculosis rates in the US. Preliminary results indicated that only 58% (2,088/3,600) of the physician respondents could correctly identify an American Lung Association, American Thoracic Society or CDC recommended treatment regimen. The study also found that 64% (2,304/3,600) of respondents would incorrectly read a tuberculosis skin test (TST or PPD). Test validity was not addressed in the preliminary report. The study needs to be fully evaluated when published, but preliminary results are at least intriguing.

The third study examined physician attitudes and practices specifically related to tuberculosis skin testing. The objective was to assess physician agreement with and adoption of American Academy of Pediatrics' (AAP) recommendations for tuberculosis screening in children. This study was important because between 1985 and 1992 a 35% increase in cases involving children occurred. In response to changing epidemiology, the AAP published new guidelines for skin testing in January of 1994. The guidelines included: (a) routine testing for low risk children is not necessary, (b) annual Mantoux testing for children at high risk and (c) periodic Mantoux testing (at one year, preschool, and adolescence) for low risk children living in areas with high TB prevalence or for those with uncertain risk. They recommended elimination of the multiple puncture test (MPT). A random sample of 1272 pediatricians and family practice physicians from four mid-Atlantic states were included in the study. The study found that physician practices

vary widely, and most do not adhere to AAP guidelines. MPTs were still used by 29% (208/718) of the respondents. Of those using MPT testing, 91% (189/208) allowed parents to read the test. Almost 20% of those using Mantoux testing allowed parental reading of the results (Pouchot et al., 1997). Howard and Solomon (1988) showed that only 37% of patients recognized a reaction that was judged positive by two experienced readers. Numerous studies indicate that the main weakness of the Mantoux PPD test is the variability of results, even when read by experienced personnel (Chaparas, 1985; Sbarbaro, 1985).

Findings from previous studies suggest that when TB prevention and control guidelines have been ignored, outbreaks of TB have occurred (Williams, Schneider & Gilligan, 1995). Multiple drug resistant tuberculosis (MDR-TB), combined with HIV, drug abuse and poor compliance with treatment has caused serious outbreaks (American Lung Association, 1996). Most affected have been: those in homeless shelters (Barnes et al., 1996), in prisons (Skolnick, 1992; Takashima et al., 1996), and those in long term care facilities and hospitals (Beck-Sague' et al, 1992; CDC, 1994c; Griffith, Hardeman, Zhang, Wallace & Mazurek, 1995; Jarvis, 1995; Jereb et al., 1995). Grimes et al., examined eight hospital nosocomial outbreaks, concluding that nurses and housekeepers have the highest risk for nosocomial TB infection (Grimes et al.,1996). Because of their access, Emergency Departments (ED) frequently care for patients at high-risk for TB. Based on skin test conversion rates for 1991 and 1992, it has been concluded that there is significant and increasing risk for nosocomial transmission of disease in the ED setting (Moran, Fuchs, Jarvis & Talan, 1995). One patient spent only four hours in the ED, but

was believed responsible for 16 TB skin test conversions among 112 ED employees. Five of those contracted active tuberculosis disease (Moran et al., 1995).

Medical student risk has again become an issue after a serious outbreak resulting from autopsy of an undiagnosed patient (Templeton, Young, Stead & Bates, 1995). Fagan and Poland (1994) conducted a survey of medical schools, collecting data on requirements for TB testing, conversion rates, and risk factors for TB. They concluded that current skin testing programs in U. S. medical schools are inadequate, though some schools reported annual conversion rates as high as 10%.

In response, Nolan (1994) points out some difficulties with the study, and with most epidemiological studies of TB. Application and interpretation of tuberculin skin testing is often not controlled for technique. Nolan further notes that factors other than tuberculosis infection may affect response to intradermal injection of tuberculin: The host's immune status, exposure to other strains of mycobacteria, past BCG administration, and perhaps the brand of tuberculin used may all be factors. Dooley (1994) concurs and also cites possible errors in the way the tests are administered or read for inconsistency in predicative values and occasional reports of large numbers of false-positive readings.

Military Issues in the Literature

The Centers for Disease Control and Prevention Guidelines clearly state that the probability that a person exposed to TB will become infected depends primarily on the concentration of infectious droplet nuclei in the air, and the duration of exposure to that air (CDC, 1994c).

The closed ventilation system of the U. S. Navy's hospital ship Comfort is a well known problem, particularly when dealing with airborne disease transmission. During recent deployment to Haiti, the patients with known or suspected tuberculosis were cared for on deck (CDR. J. Logeman, personal communication, March, 1996). While this may work in non-critical cases during ideal weather conditions, there are strong implications for Navy hospital ships participating in humanitarian missions.

In 1987, aboard another Navy vessel, two Navy physicians reported a TB outbreak. One sailor developed a smear positive, cavitary, pulmonary TB. Contact investigation found: (a) 216 new PPD converters (24.5 % of 881 previously negative sailors); (b) 95% (15/16) of sailors in the index person's department experienced PPD conversion; and (c) while all crew members were at risk for new TB infection, working and berthing in compartments far from those of the index case was found to be protective. They concluded, "the ship's closed ventilation system contributed to the outbreak" (DiStasio & Trump, 1990, p. 347).

Between 1950 and 1990 the number of airline passengers traveling on long, international flights jumped from two million to 280 million. Past studies of aircraft cabins have shown that air quality, expressed in levels of carbon dioxide, fails to meet the standards of many U.S. working places (Garrett, 1994). A 1993 to 1995 CDC investigation of six instances of passengers or flight crew traveling on commercial aircraft while infected with active tuberculosis led them to conclude, "The risk for M. tuberculosis transmission on an aircraft does not appear to be greater than in other confined spaces"(CDC, 1995, p. 140). It has been demonstrated that confined or poorly

ventilated spaces are potential sources for infection outbreak. Deployment to developing nations where HIV and TB are endemic, particularly for humanitarian missions, increases risk of exposure to undiagnosed tuberculosis.

Planners for deployment must involve health care providers in a realistic assessment of health risks if health promotion and health maintenance, rather than disease intervention in a crisis, are the goal. Experience has shown that no deployment promises absolute isolation from the local population. The WHO Health Monitoring Unit, in Croatia recently stated that humanitarian aid will become more important because wars threatening large civilian populations have become more common.. (Weinberg & Simmonds, 1995). Colonel, U.S.A., William Ethington, former Army group commander during Desert Shield/Storm, confirmed the fact that although policy may say that the mission of a deployed medical treatment facility is solely to provide medical care for U.S. forces, in reality, a number of factors can radically change the policy (W. E. Ethington, personal communication, August 26, 1996).

Gaps in Knowledge

Disaster relief and complex humanitarian missions are comparatively new to the military. Accustomed to training for war, planners are having to shift paradigms to adjust for other contingencies. Medical personnel will need to be prepared to deal with starvation, infectious disease and potential terrorism (Ryals & Baker, 1996). To evaluate training requirements a needs assessment, or evaluation of current knowledge, may be a place to start.

An epidemiological report describes the numbers of Haitians treated for TB and the number of Haitians on prophylactic TB treatment for a specified period during1994. Part of the report focuses on redeployment PPDs for 435 Navy and 256 Marine Corp personnel. According to the report, all redeployment PPDs were negative. ("Communicable Disease Report for Operation Sea Signal 1994", CDR. T. Hooker, February 14, 1995). The statistics from this, and many of the other humanitarian missions do not provide more than a snapshot view of the conditions. For purposes of preparation, military medical planners must have more consistent, meaningful data. Too little time and too few military personnel were involved to make any generalizations about the deployment or draw implications for future tuberculosis management. The MRSP has recognized the need for reliable data and has assigned Armed Forces Medical Information Command (AFMIC) to initiate a data repository (Personal communication, Lt.T. Shaw, Deployed Medical Systems, Ft. Dietrick, MD, August 1996).

Although literature describing TB, its treatment, and epidemiology is voluminous, new findings are few. Studies, investigating the knowledge and attitudes of health care providers toward tuberculosis skin testing are rare. Literature addressing singular aspects of the nurse practitioners role do not deal with infectious disease, and certainly not specifically tuberculosis.

CHAPTER THREE: METHODOLOGY

Introduction

Few studies have been done examining health care provider knowledge, attitudes or practices. Despite increasing TB infection in the United States and world wide, research indicates a lack of knowledge among physicians (Cheng, Miller, Ottolini, Brasseux & Rosenquist, 1996; Hong, et al., 1995). Many feel the disease is not easily transmitted to otherwise healthy populations so it is not a threat (American Lung Association, 1996). Others may lack concern because antibiotics, at least until now, have been effective as a treatment for the disease (O'Meara, 1994). Military medical health care providers are among those who may be called upon to diagnose and treat tuberculosis at home or in a deployment situation.

This chapter will discuss the research design and methodology selected for this study. It will describe the sample characteristics and instrument development, including reliability and validity measures used. It will also discuss data collection, protection of human subjects, and research methods.

Research Design and Procedures

This was a descriptive correlational study with two purposes: first, to describe Air Force health care provider's knowledge of *Mycobacterium tuberculosis* skin testing principles and second, to determine if demographic factors are predictive of that knowledge. Knowledge was based upon 16 elements drawn from Air Force Instruction 48-115 entitled, the Tuberculosis Detection and Control Program (1994), the american Thoracic Socitey Statement (1990), and the Centers for Disease Control and Prevention

Guidelines for Preventing the Transmission of Mycobacterium tuberculosis in Health Care Facilities (1994).

The Instrument

No valid, reliable tool to measure knowledge of tuberculosis skin testing was available for use in the study. An unpublished CDC study investigating the TB related knowledge and practices of physicians had utilized a twelve page survey. The survey tested TB care from case-finding to treatment follow-up. Replication of the CDC study was beyond the scope of this thesis. What was needed was a simple tool that focused on the small but crucial practice of tuberculosis skin testing. It required a tool that could be utilized by persons in deployable military health care provider roles. This instrument was created to reduce time investment, increase readability and enhance the probability of maximum return. The instrument follows the CDC and American Thoracic Society, Core Curriculum on Tuberculosis closely (1994c).

The focus was on tuberculosis skin testing as a preventive-type of medical service impacting on health-related behaviors, individual social and physiological factors, and physical-biological environment as depicted in the study framework by Albelin (1987). Questions guiding the development of the research instrument were: (a)) What is the level of health care provider knowledge of TB skin testing principles? And (b) What demographic factors are predictive of that knowledge?

First, a tool was designed to evaluate knowledge of basic principles of TB skin testing including elements: (a) related to the person tested, (b) the material used, (c) the method of administration, and (d) the interpretation and documentation of results. The

second objective of the study instrument was to elicit information about Air Force health care providers' military and medical background, and their experience with tuberculosis. Role as a health care provider was addressed because all health care providers, including IDMTs, are deployable in positions responsible for clinical decision-making (see appendix B). Demographics potentially impacting upon knowledge were determined to be those related to experience: age, number of years since graduation, board certification, number of years military service and total years as a military health care provider.

Content Validity

Review of the current literature was performed with emphasis on guidelines from the Centers for Disease Control and Prevention (1994c), the American Thoracic Society Statement (1994), and United States Air Force Instruction 48-115, (1994). The research instrument consisted of ten provider-specific demographic questions, followed by eight knowledge-based questions relative to tuberculosis skin testing. To maintain simplicity and minimize time required to complete the survey, the demographic questions were formatted as either multiple choice or fill-in-the-blank. The knowledge questions were presented as either multiple-choice or matching-type questions.

The tool was evaluated by three experts, two Uniformed Services University of the Health Sciences Department of Public Health physicians and one National Institutes of Health epidemiologist. After expert evaluation and revision, the instrument was discussed at length during the thesis proposal defense, revised, and re-evaluated by two of the experts. No changes to the instrument were made after validity was established by the experts.

Pilot Study

To determine reliability, the research instrument was administered in a small pilot study involving six students in the USUHS Graduate School of Nursing Family Nurse Practitioner program. Permission was first obtained from the department chair of the Family Nurse Practitioner program. The students were utilized as a representative population of new military health care providers. Convenience was a factor.

Each student was given an instrument with explanatory cover letter. One week was allowed for completion. The tool was administered in an uncontrolled environment. No instructions regarding utilization of resources or collaboration were given. Four of the six students completed the instrument and returned it as requested.

The research instrument was readministered, to the four respondents, three weeks after the initial testing. The tool was administered in the same manner as it had been originally. The goal was to determine if responses would be reliable over time. Chronbach's alpha was used to evaluate reliability of the instrument. The result of the Chronbach's alpha was -.3670. After consultation with research experts, it was determined that the sample was probably too small to obtain a meaningful reliability measure from the alpha coefficient (Dr. K. P. Miller, and Dr. E. Levine, Uniformed Services University of the Health Sciences, Graduate School of Nursing, personal communications, 14 March 1997).

Evaluating the survey pilot test by comparing the scores on the two administrations yielded the following results. Section A, demographics was found to correlate 100% between the first and second administration. A comparison of section B, from the first

administration to the second yielded the following: respondent A achieved 62.5% (10/16) on the first administration, and 62.5% (10/16) on the second; respondent B achieved 50% (8/16) on first administration and 37.5% (6/16) on the second; respondent C had a score of 75% (12/16) on the first administration and 68.7% (11/16) on the second; and respondent D's scores were 50% (8/16) both administrations. On the face, the comparative scores for Part B of the tool appear stable in three of four cases. Perhaps, the variance in scores for case two may have had a decisive effect on the reliability coefficient α. However, the inconclusive results and the small sample size indicate that the instrument should be refined and the reliability issue resolved prior to any attempt at study replication.

Approval Process

Approvals for the study were obtained from the thesis committee, the Institutional Review Board (IRB) of the uniformed Services University of the Health Sciences, and the director of medical education at the study site. Air Force survey approval was waived by the local Air Force research representative because the survey was knowledge rather than opinion-based and utilized only one Air Force medical treatment facility.

Protection of Human Rights

The study was an anonymous survey accomplished through voluntary participation. Only health care providers were surveyed. No patients were in any way involved in the research process. Completion, and return of the questionnaire represented consent to participate. Withdrawal from the study was accomplished by simple failure to return the survey. Efforts to preserve anonymity included: (a) absence of identifiers on both the

cover letter and survey; (b) return envelopes were unmarked to maintain anonymity of origin, (c) names of participants were not known, (d) no follow-up was attempted, and (e) data were presented solely in aggregate form.

Sample

The survey targeted a population consisting of a convenience sample of military health care providers at one mid-size Air Force medical treatment facility chosen for its close proximity. Potential participants were drawn from the professional directory obtained from the credentials office at the facility. All providers in the following roles were selected: medical doctor (MD), doctor of osteopathy (DO), physician assistant (PA) and nurse practitioner (NP). A list of independent duty medical technicians (IDMT) was obtained through the facility staff development office.

The survey packet consisted of the research instrument, cover letter and return envelope enclosed in a sealed, individually addressed envelope. The cover letter explained the identity of the investigator, the purpose of the survey, the suspense date, method of survey return, and the telephone number where the investigator could be reached for questions related to all aspects of the research. Three letter office symbols of each addressee were included on the address portion of the envelope. The packets were hand delivered by the investigator to mail boxes at the medical treatment facility (MTF). Mail boxes are marked with office symbol only, so surveys were grouped in the boxes. Through prior arrangement, the surveys were returned through the distribution center to the staff development office where they were accumulated for the investigator to retrieve in 14 days.

Summary

Chapter Three has described the methodology utilized in the completion of the study. The study was conducted at one 200 bed Air Force MTF for convenience and because the population of health care providers was considered representative of the larger population of all Air Force health care providers. It was anticipated that recent Air Force permanent change of station policies would assure a representative sample of providers with regard to deployment experience, age, and time in military service. Estimates of reliability and validity were obtained for this instrument with this population. The instrument was placed by the investigator into provider's office mailboxes. Surveys were returned in pre-addressed envelopes to the staff development office where they were again returned to the investigator. Chapter Four will discuss the results of data collection.

CHAPTER FOUR: DATA ANALYSIS

Introduction

The purpose of this study was to, first, describe Air Force health care provider's knowledge of *Mycobacterium tuberculosis* skin testing principles and second, to determine if demographic factors are predictive of that knowledge. Although it is commonly understood that TB skin testing is neither 100% sensitive nor 100% specific for *Mycobacterium tuberculosis*, it remains the only test available for screening asymptomatic populations. Clinical diagnosis and treatment requires understanding of epidemiology, including patterns of the disease in different populations. This study involved the collection of data related to basic knowledge necessary for military health care providers to effectively manage personnel in or from TB endemic areas. This chapter will recount, in detail, data extracted from the variables examined.

Sample characteristics

Surveys were distributed to a total of 172 Air Force health care providers: including: 148 medical and osteopathic doctors, 6 nurse practitioners, 12 physicians assistants and 6 independent duty medical technicians. A total of 65 responses were received within the allotted 15 days for a 37.7% (65/172) response rate. No responses were received after the collection deadline. One survey was discarded as unusable due to the amount of missing information. The number of surveys utilized for collection of statistical information was 64. Anonymity was preserved, so non-responders were not identified nor was follow-up attempted. It was beyond the scope of this study to

determine if the respondents differed from non-respondents with regard to the variables examined in the study.

The Data

Table 1 summarizes the ratio of provider roles seen in the Air Force and the ratio of providers in the study sample. Approximately 80% (3114/3740) of Air Force providers are medical or osteopathic doctors (Major K. Conrad, Military Personnel Center, Randolph, Texas, personal communication, 14 March 1997). The study sample also consisted of approximately 80% (53/64) medical and osteopathic doctors. Nurse practitioners comprise 5.6% (210/3740) of Air Force health care providers while they were 3.1% (2/64) of the study sample. The proportion of health care providers that are physician assistants in the Air Force is 11.1% (416/3740). They were 9.4% (6/64) of the sample population. Information regarding the numbers of Air Force independent duty medical technicians was unavailable, but they comprised 4.7% (3/64) of the sample.

Table 1

Sample Population Health Care Providers (HCP) Compared to United States Air Force Population

Type HCP	Total N	(%)	Sample N	(%)
Medical doctor and doctor of osteopathy	3114	83.2	53	82.8
Nurse Practitioner	210	5.6	2	3.1
Physician Assistant	416	11.1	6	9.4
Independent duty medical technician	Statistic not available yet	----	3	4.7
Total	3740	100	64	100

Note. Total N = Total number in USAF (USAF Military Personnel Center, Randolph, TX); Sample N = Number in sample; percent (%) = Valid percent

Data analysis was achieved by first, performing frequency distributions of the demographic variables. The goal was to describe the variation in characteristics of health care providers. The demographic variables investigated were: type of provider role, specialty certification, type of education, time since graduation from school, age, history of deployment, experience caring for tuberculosis patients, total years in military service, total years as a health care provider and time since last PPD.

While 37.1% (23/62) of the providers did not have specialty certification, 62.9% (39/62) had certification status. Approximately 3.1% (2/64) did not answer this question. Health care providers held a variety of specialty certifications including: 3.2% (2/62) in

surgery sub-specialties; 3.2% (2/62) orthopedics; 19.4% (12/62) family practice; 6.5% (4/62) in OB/GYN; 9.7% (6/62) internal medicine; 1.6% (1/62) in dermatology; 6.5% (4) pediatrics; 1.6% (1/62) were infectious disease specialists; 1.6% (1/62) endocrinology; 4.8% (3/62) in emergency medicine and 4.8% (3/62) in neurology. Table 2 describes each of the board certifications by frequency and percent of total.

Table 2

Board Certification Status For Air Force Health Care Providers In All Roles.

Certification type	N	%
Surgery (including all subspecialties)	2	3.2
Orthopedics	2	3.2
Family practice	12	19.4
Obstetrics and gynecology	4	6.5
Internal medicine	6	9.7
Dermatology	1	1.6
Pediatrics	4	6.5
Infectious disease	1	1.6
Endocrinology	1	1.6
Emergency medicine	3	4.8
Neurology	3	4.8
No certification	23	37.1
Total	62	100.0

Note. N = Frequency; (%) = Valid percent of each variable

Health care providers have three major ways in which to obtain education: (a) they may enroll at the graduate level at USUHS or a civilian university for medical or nurse practitioner education; (b) they may matriculate as undergraduates at civilian university for education in the physician assistant role; or (c) they may attend specialized military training for a few remaining nurse practitioner roles and all independent duty medical technician roles. In this study, 65.6% (42/64) of the population attended a civilian university. The Uniformed Services University of the Health Sciences had been chosen by 21.9% (14/64) for their education. Specialized military training, provided education for the other 12.5% (8/64) of the study population. Educational data for this sample is summarized in Table 3.

Table 3

Source of Health Care Provider Education

Type of institution	N	%
Civilian university	42	65.6
Uniformed Services University of the Health Sciences (USUHS)	14	21.9
Specialized military training	8	12.5
Total	64	100.0

Note. N = Frequency of response; (%) = Valid percent of each variable

Measure of experience was approached in several ways. The first was the variable 'total years since graduation from school'. School, the instrument explains, refers to the civilian university, USUHS or specialized military training referred to in the previous

question. The instrument asked for year of graduation. From that date, total years since graduation were calculated by simple subtraction. For reporting purposes, the data were compiled into five groups. Those with one to five years experience since graduation comprised 47.6% (30/63) of the sample. Another significant proportion, 30.1% (19/63) had six to ten years experience. Groups representing increased longevity included 14.4% (9/63) with eleven to fifteen years, 4.8% (3/63) at sixteen to twenty years, and 3.2% (2/63) had greater than twenty years experience. The mean amount of time (in years) was calculated to be 7.16 years, with a standard deviation of 3.49. Table 4 summarizes the data.

Table 4

Total Years Since Graduation From Civilian University, USUHS or Specialized Military Training.

Years since graduation	N	%	Mean (years)	Standard Deviation
1 - 5	30	47.6	N/A	N/A
6 - 10	19	30.1	N/A	N/A
11 - 15	9	14.4	N/A	N/A
16 - 20	3	4.8	N/A	N/A
Over 20	2	3.2	N/A	N/A
Total	63	100.0	7.16	3.49

Note. N = Frequency of response; (%) = Valid percent of each variable;
N/A = not applicable

Health care provider age is a second variable indicative of provider experience. Age was grouped into segments: 20-29 years, 30-39 years, 40-49 years and 50 or more years. The largest group, 30-39 years, represented 57.8% (37/64) of the sample population. The 20-29 year age group represented 23.4% (15/64). Those 40-49 years equaled 15.6% (10/64) of the total, while respondents 50 or older comprised 3.1% (2/64). The mean was estimated within the 30-39 years segment of the sample population. Absolute mean was not calculated because the data were unavailable for such calculation. Table 5 captures the data collected for the age variable.

Table 5

Age of Health Care Provider In Years.

Age	N	%
20 - 29	15	23.4
30 - 39	37	57.8
40 - 49	10	15.6
50 or more	2	3.1
Total	64	100.0

Note. N = Frequency of response; (%) = Valid percent of each variable

A third approach to evaluation of experience examined deployment history. Areas of the world known to be endemic for TB were listed. Respondents were asked to indicate all deployments. The majority, it was found, have never been deployed to areas outside the CONUS, 62.5% (40/64). None of the respondents had been deployed to Central America. Southwest Asia accounted for 14.1% (9) of deployments. Southeast

Asia was the site of deployment for 9.4% (6/64). Africa accounted for 7.8% (5/64) of deployments, the Caribbean Sea, 3.1% (2/64) and Pacific Islands, 4.7% (3/64). Responses to the category, 'other' included permanent change of station or temporary duty assignments in Europe, including Spain, Norway, United Kingdom and Germany. Other assignments, also in the 'other' category included, Diego Garcia, Iceland, China, Hong Kong, Singapore, Turkey, Okinawa, Italy, Korea, Africa, Southeast Asia and the Middle East. See Table 6.

Table 6

Health Care Provider History of Deployment to Areas Endemic For *Mycobacterium Tuberculosis.*

Past deployment location	N	%
Southeast Asia	6	9.4
Southwest Asia	9	14.1
Africa	5	7.8
Central America	0	0.0
South America	1	1.6
Caribbean Sea including Haiti and Cuba	2	3.1
Pacific Islands including Guam and the Philippines	3	4.7
Other (not mentioned)	8	12.5
Have never been deployed outside of the continental United States	40	62.5
Total	64	100.0

Note. N = Frequency of response; (%) = Valid percent of each variable

Experience specific to tuberculosis may be measured, in part, by the number of TB patients seen during a health care provider's career. The response to this issue includes: 64.1% (41/64) have diagnosed or treated *Mycobacterium tuberculosis* one to fourteen times in their career; 31.3% (20/64) have not diagnosed or treated a single TB patient during their career. A small percentage 1.6% (1/64) and 3.1% (2/64) have cared for 15 - 30 TB patients during their career. This variable is described in Table 7.

Table 7

Number of Cases of *Mycobacterium Tuberculosis* Treated During Career As a Military Health Care Provider.

Number of cases	N	%
None	20	31.3
1 - 14	41	64.1
15 - 30	1	1.6
> 30	2	3.1
Total	64	100.0

Note. N = Frequency of response; (%) = Valid percent of each variable

Data shows variability in the total time served in military service and the time served in military service as a health care provider. Data reflecting total years in military service was acquired in ranges, not in exact year figures. Those serving zero to five years in the military comprised 37.5% (24/64) of the sample. The next cohort, by frequency, six to ten years, elicited 31.3% (20/64). Those with 11-15 years included 17.2% (11/64) of the

sample. Those with sixteen or more years in the military service, for this population, represented of 14.1% (9/64). See Table 8.

Table 8

Total Years of Military Service.

Years of military service	N	%
0 - 5	24	37.5
6 - 10	20	31.3
11 - 15	11	17.2
16 or more	9	14.1
Total	64	100.0

Note. N = Frequency of response; (%) = Valid percent of each variable

The variable, total years as a military health care provider (Table 9), was reported in aggregates of five years. Health care providers with zero to five years in that role comprise 60.9% (39/64) of the sample. The cohort 21.9% (14/64) represented six to ten years. Those with 11-15 years represented 7.8% (5/64) and 9.4% (6/64) claimed 16 or more years as military health care provider.

Table 9

Total Years As a Military Health Care Provider.

Years as a military health care provider	N	%
0 - 5	39	60.9
6 -10	14	21.9
11 - 15	5	7.8
16 or more	6	9.4
Total	64	100.0

Note. N = Frequency of response; (%) = Valid percent of each variable

The demographic variable, time since last PPD (Table 10), yielded the following data. First, 84.4% (54/64) have a documented PPD within the past year. 10.9% (7/64) received their last PPD in the thirteen month to two years time frame. Those reporting two years or longer since last PPD comprised 4.7% (3/64) of the sample. The three respondents in this group have history of positive PPD, and are no longer tested with PPD. Two of the three had completed INH preventive therapy and one reported annual chest x-rays. See Table 10 for summary of these figures.

Table 10

Time Since Last PPD.

Last PPD	N	%
< 1 year ago	54	84.4
13 months - 2 years ago	7	10.9
2 years (due to past positive PPD)	3	4.7
Total	64	100.0

Note. N = Frequency of response; (%) = Valid percent of each variable

The second section of the study instrument contained eight questions based on knowledge of TB skin testing. Two of the questions were subdivided, one into four parts and the other into six. This was done for coding purposes because the two questions were comprised of four and six separate correct answers respectively.

The total possible correct score was 16. Two separate scores were calculated, however, one deleting the final six-part question. The first, with 16 possible correct answers, was calculated using the formula: Total score = a + b + c + d + e + f + g + h + i + j + k + l + m + n + o + p. The second, with 10 possible correct responses, was calculated using the formula: Total score = a + b + c + d + e + f + g + h + i + j. The reasons for the two step approach to the variable "Knowledge" will be discussed in Chapter 5. For the first, 16 element test, 25.0% (16/64) of Air Force health care providers correctly answered 80% (13/16) of the elements. The 10 element survey, calculated at the 80% (8/10) correct level, elicited a frequency of 46.8% (30/64) of this sample.

Table 11

Knowledge: 80% or More Correct Response to Survey Evaluated Two Ways.

Number of survey questions considered	N	%
16 *	16	25.0
10 **	30	46.8

Note. N = Frequency of 80 percent or better response; (%) Valid percent with 80 % or better. * A possible score of 16 included six questions requiring specific knowledge of current CDC guidelines relating size of reaction to host risk factors. ** A possible score of 10 included only the basic TB skin testing information about the host, the tuberculin, the method of administration, and general cautions related to interpretation of results.

The inferential statistics, examined relationships between individual demographic factors, found in section A of the instrument, and knowledge in section B. Knowledge, for this purpose, was defined as a correct score of 80% for section B of the instrument. Significant ($p \leq 0.05$) Pearson correlation of +.303 resulted from correlation of the dependent variable, 'knowledge', with the independent variable, 'years as a military health care provider'. Two significant correlations ($p \leq 0.01$) resulted in an $r = +.463$ correlation of' knowledge' with 'years since graduation', and 'knowledge' with 'age in years' produced an $r = +.450$.

Table 12

Correlation of the Dependent Variable, Knowledge, With Independent Demographic Variables.

X (independent variable)	r	2-tailed α
Years since graduation	+.463	0.01
Age in years	+.450	0.01
Years as a military health care provider	+.303	0.05

Note. X = independent variables, all which were correlated with the constant, dependent variable Knowledge; *r* =Pearson's coefficient; α = level of significance

Summary

This chapter has described the analysis of data compiled during investigation of Air Force health care provider knowledge of *Mycobacterium tuberculosis* skin testing. Demographic factors have been described in detail and 'knowledge' factors have been defined and reported. Chapter Five will discuss the findings and implications of the study.

CHAPTER FIVE: CONCLUSIONS AND RECOMMENDATIONS

Introduction

"Everything is peaceful and quiet and only mute statistics protest." (Chekhov, 1896/1982, p. 141).

It has been quiet in the realm of research into health care provider involvement in one of the world's oldest and most formidable problems – tuberculosis. The insular quality of life in developed nations has served, until now, as protection against the harsh realities of endemic disease. The increasing threat of resistant microbe strains, combined with the enhanced mobility of the world populace, have brought the problem to our doorstep. Although the results of this study are not conclusive or broadly generalizable, they do point out the need for further research into this area.

Findings Related to Demographic Variables

The proportion of survey respondents to this study generally matched the proportionate numbers for all Air Force physicians and non-physician providers (see Table 1). The number of non-physician respondents in this study included only two NPs, six PAs and three IDMTs. For this reason, no attempt was made to describe differences in demographics or knowledge among the sub-groups of providers. No generalizations could be made about the larger Air Force population from responses of these cohorts.

The respondent group of health care providers came from eleven different specialties. The number of certified respondents ranged from 12 in family practice to one in dermatology, infectious disease and endocrinology. Others included internal medicine, pediatrics, obstetrics and gynecology, emergency medicine, neurology, surgery and

orthopedics. The response from specialists in neurology, surgery, and orthopedics was unexpected and may be explained by the current international attention to the topic. It may, also, simply reflect the academic atmosphere at this training hospital. One possible reason for the better than average overall response, 37.7% (65/172), is that surveys were hand-carried to respective office mail boxes. Burns and Grove (1993) place expected response rate for mailed surveys at 25% to 30%.

Demographics indicate that 65.6% (42/64) of the health care providers were educated at civilian universities and most, 77.7% (49/64), had less than 11 years 'time since graduation'. The majority of health care providers, 57.8% (37/64) were from 30 to 39 years of age, and 81.2% (52/64) were younger than 40 years. One reason for the young, inexperienced population of Air Force health care providers may be explained by the physician residency programs and subsequent military obligation, after which many leave the military to pursue civilian careers. They, in turn, are replaced by young, inexperienced providers, and the cycle repeats itself.

Study sample size (n = 2) renders it impossible to draw any conclusions about the age or experience level of Air Force nurse practitioners. One was 40 - 49 years of age, graduated from specialized military training, certified in pediatrics, had treated 1-14 cases of TB and had amassed over 16 years experience as a military health care provider. The other was 30 - 39 years of age, graduated from a civilian university, certified in OB-GYN, had seen no cases of TB, had accumulated 0 - 5 years of experience as a health care provider, and 11 - 15 years total military service. Surprisingly, neither had been deployed; possibly because of their specialties.

In a 1996 tri-service study of nurse practitioner practice settings (n = 147), Fuller found the mean age of military NPs to be 40 years (ranging from 32 to 54 years of age), with an average of 6.8 years experience as a health care provider. Over 60% (102/147) had between 10.5 and 20 years military experience. This implies that military nurse practitioners are already experienced military nurses when they become nurse practitioners. Since the time of Florence Nightingale, nurses have been leaders in infection control and disease prevention (Fitzpatrick, 1992). Nurse practitioners excel in the practice of health promotion and disease prevention (Pender, 1987). Studies have shown that NPs are more likely to provide preventive counseling, health education, and health promotion activities than their physician counterparts (Avorn, Everett and Baker, 1991). Albelin's framework for health promotion and disease prevention stresses the importance of preventive medical and related services in disease prevention.

The fact that 62.5% (40/64) of this sample of health care providers have never been deployed was surprising. In this sample, two possible causes seem likely: (a) it is possible that health care providers with deployed experience are those who, after completing military obligation, leave the military, or (b) the sample may be biased by the number of physician residents, not deployed during their education. There may also be a significant number of qualified faculty, not deployed because of the importance of their position.

Remarkable was the apparent lack of correlation between 'knowledge' and 'deployment'. Logically, it would seem, the more the deployment experience, the more the provider would know about infectious diseases, especially those not seen in CONUS.

The sample of personnel with deployment experience to TB endemic areas was small (n = 17). It would be interesting, from a readiness perspective, to know the rate of turnover for deployment-experienced health care providers.

The variable 'time since last PPD' indicates compliance with Air Force policy, as stated in AFI 48-115, section 3.1.3.(1994): "Air Force medical personnel shall receive annual TB skin testing". Of the sample, 84.4% (54/64) had received annual testing. One MD, one DO, and one IDMT or 4.7% (3/64) reported last PPD skin test "greater than two years ago". Skin testing was precluded, in each case, by past positive PPD skin test results. This question, however, highlighted an error in the survey. The question relating to personal PPD testing should, in the future, be changed to add ' past positive PPD'. Fraser (1994) found, in a recent civilian study sample, there are barriers to reaching physicians for TB skin testing. Physicians, he showed, may be screened less frequently and may not follow up with prophylactic therapy if they convert. Air Force regulations require compliance with testing and prophylactic treatment. Whether Air Force compliance is 100% is questionable.

Findings Related to Knowledge

Two measures of Section B, 'knowledge', were considered: (a) the 10 question, basic knowledge of TB skin testing, and (b) the 16 question, knowledge of TB skin testing, including interpretation of skin test results. The percent of providers answering any particular question correctly ranged from 29.7% (19/64) to 93.8% (60/64). Questions rating the lowest frequency of correct response were among the last six of the

survey. These tested knowledge of current CDC Guidelines (1994) for interpretation of TB skin testing.

In the Sumartojo, et. al. (1994) study investigating physician knowledge of TB, it was reported that over 64% of respondents would incorrectly interpret TB skin test-results. At the time the preliminary report for this study was published, Bates, then president-elect of the American Lung Association, criticized the findings. His criticism was based on the premise that the CDC periodically redefines the criteria for positivity ". . . by a few millimeters this way or that. . .(and) it is not reasonable to expect most physicians to be up to speed with the whole management of TB" (CDC, 1994a, p.6). He suggested that TB training be concentrated in geographical areas of the nation reporting highest incidence. He did agree, however, that all medical students and practicing physicians should be taught to read a skin test. Because of Bates' disagreement with the skin testing portion of Sumartojo's study, this study measured 'basic TB skin testing knowledge', deleting the last six elements of the survey.

Results appear to support research results of Sumartojo et al. Only 46.8% (30/64) of sample providers correctly answered 80% (8/10) of the basic knowledge questions. An abysmal 25% (16/64) of providers scoring 80% or more on the more complete 16 element survey. Findings indicate that this sample of health care providers, like the almost 2000 of the previous study, do not know enough about tuberculosis skin testing.

The final purpose of this study was to determine whether any demographic factors were related to knowledge of TB skin testing. The data were analyzed, using Pearson's *r*, in order to determine possible correlations. The results were not surprising, although they

appear contradictory to the earlier study. Findings in that study implied that physicians more recently graduated from medical school demonstrated greater knowledge of TB than those who had been in practice longer. In the current sample, years since graduation, age in years, and years as a military health care provider are all positively correlated with knowledge. Further investigation into factors potentially related to increased knowledge of TB are among the implications for further study.

Implications for Further Research

The major implications of this study point to a need for modification of, at least, readiness training. It is apparent that, in this sample, not enough is known about TB skin testing. Is it considered too unsophisticated and imperfect to bother to learn? Fuller's (1996) study of nurse practitioner practice settings and clinical practice activities, listed procedures and activities performed by nurse practitioners. The list of 92 procedures included the interesting: interpretation of ECG's and x-rays; and the somewhat mundane: eye irrigation, ear irrigation, and immunization administration. Tuberculosis skin testing and interpretation was not even mentioned. It would appear that nurse practitioners, like their physician counterparts, have overlooked the importance of this procedure.

The tie between health beliefs and provider practices would be worthwhile to explore. Numerous studies have examined the relationship between health beliefs and personal health behaviors. No studies could be found investigating the relationship between health beliefs and provider practices. Administration of a valid health belief

instrument along with an improved TB skin testing survey, it may allow a look at potential correlations between the two.

Suggestions for Further Research

Suggestions for further research include the following:

First, replication of the study using a larger, and perhaps random, sampling of Air Force health care providers.

Secondly, an experimental study utilizing an educational intervention, measuring improvement in knowledge scores.

Thirdly, a comparitive study investigating knowledge of TB skin testing in deployed versus stateside personnel.

Fourthly, it may be worthwhile to descriptively investigate NP practices related to disease prevention, specifically focusing on obstacles to performance of that NP role.

Fifthly, an experimental study compairing written knowledge of TB skin testing versus performance and interpretation of actual skin testing.

Summary

Rewards of an early detection program are reduction in transmission of a potentially fatal disease to patients, coworkers, or family members and reduction in lost time from work as a result of active TB (Grimes et al.,1996). Complacency regarding *Mycobacterium tuberculosis* is a luxury, no longer affordable in today's world. Although not conclusive or widely generalizable, this study does indicate a need for further education of health care providers.

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APPENDICES

APPENDIX A

Cover Letter

10 January 1997

Dear Air Force health care provider,

Do you know exactly what type of patients you will be seeing in January, 1998? Do you know where you will be seeing those patients? As a military member you can be confident of one thing -- you cannot be absolutely sure of either!

According to the Air Force Times, over 12,000 Air Force personnel are participating in major deployments in a myriad of locations outside of the United States. Today, deployed military medical personnel may diagnose and treat, not only battle injuries, but diseases like *Mycobacterium tuberculosis,* not seen in most stateside settings. In addition, immunization technicians who routinely administer and record tuberculin skin tests, may not be deployed with your unit.

As a student at the Uniformed Services University of the Health Sciences Graduate School of Nursing, I am investigating the practice of skin testing for tuberculosis (TB). Modeled after a Centers for Disease Control and Prevention study, the purpose of this survey is to describe health care provider knowledge of tuberculin skin testing. Survey participants will include those who may be deployed in one of the following health care provider roles: medical doctors, doctors of osteopathy, physician assistants, nurse practitioners, and independent duty medical technicians.

Participation in the study is voluntary. Survey results will be kept strictly confidential. Data will be analyzed and included in aggregate form without individual identifiers and no participants will be identified in any publication. Results will be available to you through your epidemiology department and in the Uniformed Services University learning resource center when the research is completed.

Please take a few minutes to complete the attached questionnaire and place it in your distribution. Completed questionnaires must be placed in distribution by February 24, 1997. If you have any questions concerning the study, please contact me at (301) 493-5022.

Thank you for sharing your knowledge.

Nancy J. Heisterman, Major, USAF, NC
Student, Family Nurse Practitioner Program
Graduate School of Nursing
Uniformed Services University of the Health Sciences

APPENDIX B

Survey Instrument

SECTION A. The following questions pertain to information about you and your background. Circle the letter next to the response that best describes your situation. Circle only one response unless additional instructions indicate otherwise.

1. What is your role as a military health care provider?

   a. MD (medical doctor)
   b. DO (doctor of osteopathy)
   c. PA (physician assistant)
   d. NP (nurse practitioner)
   e IDMT (indepentent duty medical technician)

2. If board certified in a specialty area, state which: ____________________________

   ____

3. Your professional degree or training (leading to MD, DO, PA, NP or IDMT) is from:

   a. Civilian university
   b. USUHS
   c. Specialized military training
   d. Other: ____

4. Your year of graduation from the school referred to in question number three: ______

5. Your age (in years):

   a. 20 - 29
   b. 30 - 39
   c. 40 - 49
   d. 50 +

6. Your past military deployments to any of the following areas: (circle all that apply)

   a. Asia (check which area applies to you)
      Southeast (Vietnam, Cambodia, Laos, Thailand, Korea, Japan)
      Southwest (Persian Gulf, Turkey)
   b. Africa
   c. Central America
   d. South America

e. Caribbean Sea (Haiti, Cuba)
f. Pacific Islands (Guam, Philippines)
g. Other (not mentioned)______________________________________
h. I have not been deployed outside of the continental United States

7. As a military health care provider, approximately how many cases of *Mycobacterium tuberculosis* have you diagnosed and/or treated during your career?

   a. None
   b. 1 - 14
   c. 15 - 30
   d. > 30

8. Your total years of military service:

   a. 0 - 5
   b. 6 - 10
   c. 11 - 15
   d. 16 +

9. Your years of service <u>as a military health care provider:</u>

   a. 0 - 5
   b. 6 - 10
   c. 11 - 15
   d. 16 +

10. Your last PPD tuberculin skin test was:

   a. Less than a year ago
   b. 13 months - 2 years ago
   c. > 2 years ago
   d. I do not recall
   e. I have never had a PPD tuberculin skin test

SECTION B. This section concerns your knowledge of skin testing practices for *Mycobacterium tuberculosis*. Circle the number next to the response that best describes your answer. Circle only one response unless additional instructions indicate otherwise.

1. The most widely accepted tuberculin skin test procedure used in practice today is the:

   a. Mantoux (intradermal injection of PPD tuberculin)
   b. Tine (multiple puncture test)
   c. Tine, followed by the Mantoux

2. The tuberculin skin test:

   a. is used to determine whether tuberculosis is being transmitted in a facility (indicated by skin test conversions among staff or others in the facility)
   b. is highly specific for *Mycobacterium tuberculosis*
   c. is given to persons who may have been exposed to tuberculosis regardless of their past PPD status
   d. is the only diagnostic test necessary to determine definitive treatment for *Mycobacterium tuberculosis* disease

3. Inaccurate tuberculin skin test results may occur for all of the following reasons EXCEPT:

   a. Placement of the skin test too deep
   b. Reading the skin test before 48 or after 72 hours
   c. Use of antigen that has been frozen
   d. A second PPD, given 1 to 3 weeks after the first for persons who may have had TB infection in the remote past

4. A "false negative" tuberculin skin test may occur for the following reasons: (circle ALL that apply)

   a. The person has an immunocompromising condition
   b. The person is malnourished
   c. The person has severe or febrile illness
   d. The person has overwhelming active *Mycobacterium tuberculosis* disease

5. If you suspect that the result of a tuberculin test is a "false negative", it would be appropriate to:

   a. Do no further work up; other strains of *Mycobacterium* do not result in a positive skin test
   b. Test for anergy by administering at least two other delayed-type hypersensitivity agents in conjunction with tuberculin testing
   c. Base diagnosis on the results of a CBC and sedimentation rate
   d. Isolate the person for 2 weeks, and repeat the tuberculin skin test

6. When two-step (or booster) testing is performed, the following are true EXCEPT:

   a. If the first test is positive, give the second test in 1 - 3 weeks
   b. If the first test is negative, give the second test in 1 - 3 weeks
   c. If the second test is positive, consider the person infected
   d. If the second test is negative, consider the person uninfected

7. A tuberculin skin test correctly read as "10 mm" would show:

   a. An erythematous area, measuring 10 mm long and 7 mm wide
   b. A 10 mm area of ecchymosis, with an approximate 5 mm indurated center
   c. Completely normal appearing skin, with 10 mm induration at the site of injection
   d. 7 mm induration, surrounded by 3 mm erythema

8. For each of the following cases, give the SMALLEST response necessary to interpret the tuberculin skin test as "positive". Responses may be used more than once.

_____ Persons known to have, or suspected of having HIV infection	a. ≥ 5 mm erythema
_____ Children younger than 4 years of age	b. ≥ 5 mm induration
_____ Otherwise healthy, foreign-born persons from Asia, Africa, Central or Latin America, the Pacific Islands or the Caribbean	c. ≥ 10 mm erythema
_____ Close contacts of a person with infectious tuberculosis disease	d. ≥ 10 mm induration
_____ Otherwise healthy persons from locally identified high-prevalence groups (e.g. migrant farm workers, homeless persons or prisoners)	e. ≥ 15 mm erythema
_____ Persons with no known risk factors for tuberculosis	f. ≥ 15 mm induration

This completes the survey. Please place the survey in the enclosed envelope and send through your distribution no later than 24 February 1997.

Again, thank you for your input. Further comments about the survey, or about TB are welcomed.

APPENDIX C

Glossary

Anergy: Inability to react to skin-test antigens; often caused by pharmacologic or physiologic immunosuppressed condition.

Booster phenomenon: A phenomenon in which persons who are skin tested a period of years after tuberculosis infection have a negative reaction, followed by a positive skin test. The positive test is caused by a boosted immune response. Two-step testing is used to distinguish between new infections and boosted response.

Contact: A person who shared the same air with one who has infectious TB for a period deemed long enough to allow transmission of the disease.

Convert: One who experiences a change in TB skin test results from negative to positive. A recent converter is one who shows a ten millimeter or greater increase in induration response to the PPD within a two year period (for those ≤ 35 years); or a 15mm increase in induration if ≥ 35 years.

Culture: A process, for TB usually requiring two to three weeks, in which bacteria are grown under controlled conditions for the purpose of identification.

Droplet nuclei: Microscopic (1-5 μm in diameter) particles produced when a person coughs, sneezes, shouts or sings. These may remain suspended in the air, and may be carried on air currents.

Exposure: Being subjected to something that could have a harmful effect. Persons exposed to TB do not necessarily become infected.

False-positive reaction: A positive reaction to tuberculin skin testing caused by error in administration or reading of the TB skin test.

False-negative reaction: A negative reaction to tuberculin skin testing caused by host anergy or reader error.

HIV (human immunodeficiency virus) infection: Infection with the virus that causes acquired immunodeficiency syndrome (AIDS). Hiv is the single most important factor for progression from latent TB infection to active clinical disease.

Immunocompromised: A condition, with either pharmacologic or physiologic origin, in which the immune system does not function normally. Immunosuppressed individuals are at greatly increased risk for developing active TB subsequent to infection..

Induration: An area of swelling produced by the immune response to an antigen. In tuberculin skin testing or anergy testing, the diameter of the indurated area is measured 48-72 hours after the injection, and the result recorded in millimeters.

Infection: Condition in which disease causing organisms elicit response from the immune system of the body. The infection (in the case of tuberculosis) may or may not lead to clinical disease.

Infectious disease: Diseases which is transmissible from person to person, animal to animal, animal to man or man to animal through direct contact or indirectly through a vector (e.g. fleas).

Intradermal: Within the layers of the skin.

Isoniazid (INH): A first-line, oral anti-tuberculosis drug.

Mycobacterium tuberculosis: a bacterial disease, transmitted by airborne droplet nuclei which are inhaled into the lungs of a host.

Multidrug-resistant tuberculosis (MDR-TB): Active TB disease caused by Mycobacterium tuberculosis bacteria that have become resistant to INH and rifampin (and perhaps more) anti-TB drugs.

Nosocomial infection: Infection acquired in a hospital or as a result of medical care.

Preventive therapy: Chemotherapeutic therapy to prevent progression from latent infection into active TB disease.

Purified protein derivative (PPD)-tuberculin: A tuberculin preparation, developed in the 1930's from old tuberculin. Five tuberculin units (TU) or 0.1 mL are used in the standard Mantoux test .

Regimen: A particular treatment plan specifying drugs, doses, frequency of administration, and duration of administrating.

Rifampin: First-line, oral anti-tuberculosis drug used with INH and pyrazinamide. It is never used as a single drug for TB infection or disease.

Sensitivity: The percentage of people with the condition who have a positive result to the test.

Smear (AFB smear): A slide preparation of body secretion (usually sputum) in which mycobacterium may be visualized. Non-tuberculous mycobacteria may also be visualized on smear, so culture of TB is the absolute diagnostic test. A smear takes about 24 hours, while a culture takes 3 weeks

Specificity: the percentage of people without the condition who have a negative test.

Transmission: The spread of an infectious agent from one host to another. In the case of tuberculosis, the likelihood of spread is related to duration and intensity of exposure.

Tubercle: A, usually necrotic, lesion of tuberculosis consisting of a packed mass of cells and waste products of leukocytes and bacilli.

Tuberculin skin testing: For the purpose of this study, skin testing refers to the Mantoux method of injecting 0.1 ml (5TU) of PPD tuberculin into the dermis of the volar or dorsal surface of the forearm. Millimeters of induration are measured and recorded in the record between 48-72 hours after administration. Both the implantation of the tuberculin, and the interpretation of results require absolute adherence to guidelines if accurate results are to be obtained.

Two-step testing: the procedure used for baseline testing of persons who will be receiving periodic testing. If the first test is classified as negative, repeat testing will be done 1-3 weeks later. If the second test is classified as positive, it probably represents a reaction stimulated by infection in the distant past. If the second test is negative, the person is considered negative. A positive reaction to subsequent tests would be considered new infection (conversion).

Virulence: The pathogenicity of a microbe as indicated by the severity of the disease produced and its ability to cause disease in the host.